THE EFFECT OF MONOPOLY COATING AGENT ON THE SURFACE ROUGHNESS OF A TISSUE CONDITIONER SUBJECTED TO CLEANSING AND DISINFECTION – A CONTACT PROFILOMETRIC IN VITRO STUDY

Dissertation submitted to
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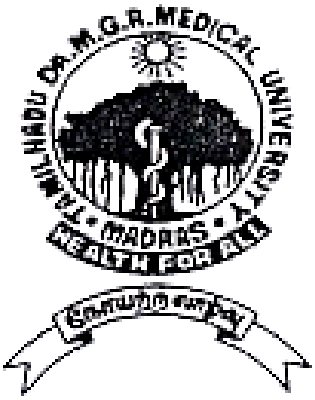

BRANCH VI PROSTHODONTICS

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CERTIFICATE

Certified that the dissertation on the **‘‘THE EFFECT OF MONOPOLY COATING AGENT ON THE SURFACE ROUGHNESS OF A TISSUE CONDITIONER SUBJECTED TO CLEANSING AND DISINFECTION – A CONTACT PROFILOMETRIC IN VITRO STUDY”** done by **Dr. Pushkar Gupta,** Post Graduate Student (MDS), **Branch VI Prosthetic Dentistry**, Saveetha Dental College and Hospitals, submitted to The Tamil Nadu Dr.M.G.R. Medical University in partial fulfillment for the M.D.S. Degree examination in March 2007, is a bonafide dissertation work done under my guidance and supervision.

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"True knowledge exists in knowing that you know nothing and in knowing that, you know nothing, makes you the smallest of all." **Socrates.**

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CONTENTS

INTRODUCTION

Tissue conditioners have been used in the management of abused tissues underlying ill-fitting dentures, for functional impressions, for temporary relining of ill-fitting dentures and immediate dentures and for tissue conditioning during implant healing.[1-4] The usefulness of these materials is attributed to their viscoelasticity that allows molding during use[5] over an extended period of time.

The viscoelastic properties after gelation of the materials influence the efficacy in the preceding applications, [5-7] because the viscoelastic properties suitable for each clinical application are different. It is suggested that a material suitable for conditioning abused tissues should be soft and elastic. However, for functional impressions, these materials should be plastic.[4,8]

They consist of a powder-liquid system made up of polymers and copolymers, with poly (ethyl methacrylate) as the main component and a mixture of ethanol and an ester plasticizer. The esters are generally aromatic esters such as butyl phthalyl butyl glycolate, dibutyl phthalate, or butyl benzoate.[9] As poly (methyl methacrylate) is replaced by higher

methacrylate (ethyl, n-propyl, and n-butyl), the glass transition temperature (Tg) becomes progressively lower, minimizing the leaching properties, linear shrinkage and the amount of plasticizer required. [10]

The properties of the tissue conditioners are affected by the moist environment of the oral cavity, where ethanol and ester plasticizer are leached into the saliva and water is absorbed by the polymeric phase of the gel, [11-16] which causes the surface to become stiff and rough.[17]

The increased porosity of the tissue conditioners can lead to plaque accumulation and Candida albicans colonization,[18,19] and the two methods to control plaque to prevent denture stomatitis include, mechanical plaque control[20,21] and chemical plaque control.[21-25] Mechanical cleaning of tissue conditioners, may lead to surface damage.[26] A chemical soaking technique is primarily the method of choice for geriatric patients and for those with poor motor capacity.[27] The solutions used for denture cleaning can be divided according to their chemical composition: alkaline peroxide, alkaline hypochlorite, acids, disinfectants and enzymes.[21] Denture cleansers have been reported to cause a significant deterioration of tissue conditioners in a relatively short time.[28,29]

It is also well know fact that the prosthesis has been identified as a source of cross-contamination between patient and dental personnel, [30-32] hence it is mandatory to disinfect the prosthesis to reduce the chances of cross contamination.

The longevity of tissue conditioner is short, from weeks to a month which necessitates frequent replacement.[33,34] Several surface coating agents (Monopoly, Palaseal, Fluorinated copolymer) extend the life of a temporary soft denture liner, because they maintain the resilient characteristics, keep it clean and smooth, and decrease the incidence of microbial growth,[33-38] however the effect of Monopoly coating on the surface roughness of a tissue conditioner subjected to the action of denture cleanser and disinfectant has not been documented.

The purpose of this study was to

1. Evaluate the surface roughness of a tissue conditioner subjected to denture cleanser and disinfectant.
2. Evaluate the surface roughness of a tissue conditioner with monopoly coating, subjected to denture cleanser and disinfectant.
3. Compare the surface roughness values and analyze the effect of monopoly coating agent on a tissue conditioner.

REVIEW OF LITERATURE

Budtz-Jorgensen E (1979)[21] - suggested that proper hygienic care of removable dentures is an important means of maintaining a healthy oral mucosa in denture wearers. The author has described the materials and methods for cleaning dentures and has discussed different means of keeping dentures plaque free.

Mahamoud Khamis Abdel Razek, Zakia Metually Mohamed (1980)[39] – studied the effect of tissue conditioners with addition of antiseptics on the oral microbial flora of completely edentulous patients. The changes were mainly attributed to the amount of time the dentures were in use. The study revealed that incorporation of antibiotics or antiseptics does not have any profound effect on the microbes, but the normal flora was replaced by gram-negative bacilli.

Abelson DC (1981)[40] - tested the plaque removal effectiveness of a new denture cleansing product and concluded that the plaque removal effectiveness of the ultrasonic device tested, when used with water alone, was found to be substantially greater than that of two popular alkaline-peroxide soak-type denture cleansers, Efferdent and Polident.

De Mot B. et al (1984)[41]- examined (Coe Comfort, FITT, Ivoseal, Visco Gel) for their impression softness and elastic recovery and it was concluded that FITT and Ivoseal are harder materials, whereas Coe Comfort and Visco Gel are softer. The ageing time has a clear hardening influence especially on Visco Gel. Visco Gel appears to be the best tissue conditioner by its relative plasticity during the first hours and its elastic behavior during a longer ageing period.

Quinn DM (1985)[42]- compared the effectiveness, in vitro, of antifungal agents (miconazole and ketoconazole) combined with tissue conditioners in inhibiting the growth of Candida albicans and concluded that Miconazole and ketoconazole were as effective as nystatin in completely inhibiting the growth of Candida albicans.

Arthur Nimmo et al (1985)[43]- determined the effect of vacuum treatment on void formation and microbial adherence to the surface of the tissue conditioning agent (Visco-gel) and it was suggested that the vacuum treated Visco gel samples contained significantly fewer voids than prepared at atmospheric pressure and that the microbial adherence was not affected by vacuum treatment.

Gardner LK (1988)[37] - described a method to reduce the incidence of fungal growth and increase the period of resiliency for temporary soft liners. He suggested that the coating of monopoly is limited to temporary soft liners only, since the coating will not adhere to the permanent soft liners.

Newsome PR et al (1988)[44] - studied the initial flow of four temporary soft lining materials, using a parallel-plate plastimeter. The results indicate that a 2-mm thickness of temporary soft lining material is considered suitable for use as a tissue conditioner. The thickness of lining material is influenced by the clinical technique and by the powder to liquid ratio; however, the scope for altering the ratio is limited.

S. S. Dills et al (1988)[23] - compared the ability of 2 denture cleanser (Dentu-Crème abrasive denture paste and Efferdent alkaline peroxide), to remove plaque micro organisms from dentures and concluded that denture cleansers caused significantly greater reduction of micro organism than did brushing with denture paste and combining brushing with the soak did not reduce the level of recoverable micro organism significantly more than soaking alone.

Harrison A, Basker RM (1989)[45] - evaluated the effect of five denture cleansers on five temporary soft materials. The materials were assessed at 3, 7, 14, and 21 days for evidence of changes in surface quality and softness and it was suggested that the correct combination of lining material and cleanser is essential to ensure the optimum function of the lining material.

K. C. White et al (1990)[46]- described a technique for making a trial base with auto polymerizing resin or visible light cured material, soft temporary liner material, and a sealant solution (Monopoly), which provides a comfortable, close fitting trial base and expose the technician to a minimum of methyl methacrylate monomer.

Y. Aslan, M. Avci (1990)[47]- investigated the effect of monopoly coating on bacteria retention and wash ability of acrylic resin surfaces and suggested that monopoly should be applied to the acrylic resin surfaces where mechanical polishing cannot be done.

Chan EC et al (1991)[48] - compared the efficacy of a soaking solution (Efferdent Extra-Strength Denture Cleanser Tablets) to mechanical cleaning with a denture paste (Advanced Formula Dentu-Creme Denture Cleaning Paste) to remove and kill plaque bacteria from

removable dentures and the results demonstrated the superior performance of Efferdent over Dentu-Creme.

Fumiaki Kawano et al (1991)[49] - studied the influence of soft lining materials on pressure distribution. The results of this research suggested that a 3mm thickness of soft lining material is most suitable for distributing the pressure on supporting tissue under the denture.

Jeffrey Wilson (1992)[50] - investigated the rate of alcohol loss from 2 tissue conditioners (Coe-Comfort and Ivoseal) by applying them to complete denture record bases and immersing them in water in a sealed container. Samples were taken regularly and analyzed by gas chromatography. The loss occurred in the first 12 hours and was maximum at approximately 60 hours.

S. Murakami et al (1992)[51]- measured the dissolution of ethanol and butyl phtalyl butyl glycolate to investigate the relation to dimensional change and also evaluated the shrinkage of the materials in relation to particle size in powder and the ethanol content in liquid. On the basis of the results it was suggested that dissolution of ethanol is related to shrinkage of tissue conditioners with time and that the component particle

size in the powder and ethanol content in the liquid have a significant influence on dissolution of ethanol associated with shrinkage.

David M. Casey, Ellen C. Scheer (1993)[34]- used several surface conditioning agents (mono-poloy glaze and Minute-stain glaze) on a temporary soft lining material and analyzed the samples by scanning electron microscope to evaluate the longevity of temporary soft lining material and concluded that initially all the materials were intact but after thirty days the materials deteriorated producing pits and holes. The author suggest that this may be due to improper mixing with incorporation of air bubbles.

Jepson N.J. et al (1993)[52] – studied the viscoelastic properties of some temporary soft lining materials both in vivo and in vitro using force/distance probe. The study was conducted over a period of eight weeks and it was observed that the reduction in viscoelastic properties was noted rapidly in the first week.

H. Murata et al (1993)[53]- studied the effect of the molecular weight of polymer powder, the ethyl alcohol content, the type of plasticizer and the polymer P/L ratio on viscoelastic properties during gelation of tissue conditioners with an oscillating rheometer. The results

showed that (a) The gelation time decreased with increase in molecular weight of the polymer powder and with P/L ratio (b) Gelation time decreased with increased in ethyl alcohol content (c) The type of plasticizer affected gelation time. The order of gelation time was: benzyl benzoate < dibutyl phthalate < butyl phthalyl butyl glycolate.

F. Kawano et al (1994)[11]- evaluated the sorption and solubility of 12 soft denture liners and concluded that since sorption and solubility are accompanied by a volumetric change, bacterial infestation, hardening, and color change may effect the long term life expectancy of the soft denture liner.

Hiroki Nikawa et al (1994)[28] - investigated the deterioration of resilient denture lining materials immersed in denture cleansers and concluded that the grades of surface porosity of soft liners varies depending on the immersion time and various components of denture cleansers and soft lining materials, particularly peroxides, in cleansers and gel formation components of soft liners play important roles in the deterioration of soft liners caused by cleansers.

H. Murata et al (1994)[54]- studied the effect of both the ethyl alcohol content and the type of plasticizer on the viscoelastic properties

after gelation of tissue conditioners by means of a stress relaxation test and summarized that (a) the liquid containing the larger percentages of ethyl alcohol produced the larger flow after gelation and had a significant influence on changes in viscoelastic properties with passage of time (b) the use of benzyl benzoate produced the larger flow after gelation than dibutyl phthalate, which in turn produced the larger flow than butyl phthalyl butyl glycolate (c) the type of plasticizer was found to have no influence on changes in viscoelastic properties with the passage of time.

Naofumi Shigeto et al (1995)[55] – evaluated the influence of powder particle size and ethanol content in liquid of tissue conditioners ,on the distribution of pressure changes over time at the denture periphery and the residual ridge crest and concluded that greater the ethanol content of the liquid and smaller the powder particles size, the lower is the pressure at the buccal denture periphery.

Nanette E. Dominguez et al (1996)[35] - evaluated the ability of Monopoly to prevent water absorption and plasticizer loss from a tissue conditioner (Visco-gel). Water absorption was determined gravimetrically and decanted water was subjected to separation by component identification. All samples suffered significant initial weight loss followed by a trend towards weight gain in the uncoated control

group, probably because of water absorption. The monopoly coating appeared to reduce this effect. Plasticizer loss from the tissue conditioner was below quantifiable limits.

Kokubyo Gakkai Zasshi (1997)[56]- determined the effect of a soft liner applied to complete dentures on masticatory functions by comparing occlusal force, masticatory performance, masseter muscular activity, and mandibular movement between new dentures and relined dentures. The results of this study were that the occlusal forces were significantly larger, masticatory performance in chewing peanuts increased slightly, the number of strokes and time for masticating a peanut decreased significantly, masticatory muscles functioned more rhythmically and mandibular movements became smoother and Integrated EMGs per stroke of all patients was similar.

Iwao Hayakawa et al (1997)[33] - examined the intra oral changes of the elastic properties and roughness of a tissue conditioner after treatment with a fluorinated copolymer coating agent. The surface of the conditioner was treated with the agent on half of the internal surface of five maxillary complete dentures and was compared with the untreated half on the other side. The cushioning effect of the conditioner was evaluated by measuring the creep compliance strain-to-stress ratio. The

value of compliance on the treated half was significantly greater than that on the untreated half. There was significantly less roughness on the treated side than on the untreated side. It was found that the coating provides an improved, glossy surface to the conditioner and may increase its useful life.

Pete M. Gronet et al (1997)[38] - determined whether coating temporary soft denture liners with two different denture surface sealants (Monopoly and Palaseal), followed by thermocycling, affects the resiliency of liners. Samples were thermocycled from 5º C to 45º C for 500 cycles and then compressed 10mm on an Instron universal testing machine. Resiliency was determined by measuring the energy absorbed when stressed to a specific yield point. It was concluded that surface coating increased the resiliency of soft liners when compared with uncoated samples.

Kulak Y, Arikan A, Kazazoglu E. (1997)[57]- Investigated the existence of C. albicans and microorganisms in subjects with and without denture stomatitis showed that a combination of C. albicans and microorganisms is more likely to be responsible for denture stomatitis.

Verran J, Maryan CJ. (1997)[19]- compared the retention of Candida albicans on smooth and rough acrylic resin and silicone surfaces after a washing procedure to determine the effect of surface roughness on prosthesis infection and hygiene and concluded that the resultant surface roughness may facilitate microbial retention and infection and should therefore be kept to a minimum.

M. G. J. Waters et al (1997)[58] - determined the extent of candidal adherence to silicone soft lining materials and compared with a commercially available soft lining material and an acrylic resin denture base and concluded that the adherence of Candida albicans to silicone soft lining materials was significantly less than that for an acrylic resin denture base and a commercially available soft lining material.

Hiroshi Murata et al (1998)[8] - suggested that each material should be selected according to each clinical purpose because of the wide ranges of viscoelastic properties and changes in viscoelasticity with time among the materials. Furthermore, gelation times and the viscoelastic properties after gelation can be controlled to improve handling and suit various application by altering the P/L ratio within the acceptable limits.

Radford DR et al (1998)[59]- assessed the adherence of Candida albicans to heat-cured hard and soft denture-base materials with varying surface roughness, and observed the effect of a mixed salivary pellicle on candidal adhesion to these surfaces and concluded that the rough surfaces on denture-base materials promotes the adhesion of C. albicans in vitro and saliva reduces adhesion of C. albicans and thus diminishes the effect of surface roughness and free surface energy differences between materials

H. Murata et al (1998)[60] - suggested that the lower molecular weight polymer powders produced the larger flow after gelation especially at long times and the use of a lower powder/liquid ratio produced a greater flow after gelation at both short times and long times.

Aylin Baysan et al (1998)[24]- determined the effectiveness of microwave energy in the disinfection of a long term soft lining material (Molloplast b) and concluded that disinfection in dilute sodium hypochlorite solution proved to be more effective than exposure to microwave energy.

Chow CK, Matear DW, Lawrence HP (1999)[61]- investigated the effectiveness of antifungal agents incorporated into tissue conditioners in

treating candidiasis. Combinations of nystatin, fluconazole, itraconazole and Coe Soft, Viscogel, Fitt were tested at 1, 3, 5, 7, 9 and 11 wt/wt%, with and without sterilized saliva and it was concluded that the treatment of chronic atrophic candidiasis by incorporation of antifungal drugs into tissue conditioners is efficacious.

Robert W. Loney et al (2000)[62] - examined the effect of finishing and polishing procedures on surface roughness of (Lynal, Visco-gel, Coe-Soft and FITT) and concluded that the polished samples had lower mean surface roughness measurements.

Luciano Olan-Rodriguez, Glen E. Minah, Carl F. Driscoll (2000)[36]- evaluated the effect of 2 different denture surface sealants [Palaseal and Monopoly] on the microbial colonization of a newly placed soft interim denture liner during a period of 14 days and concluded that the coating of denture liner with either Palaseal or Monopoly significantly decreased yeast and bacterial colonization.

Alcibiades J. Zissis et al (2000)[18]- investigated the roughness of 20 denture materials [4 denture base resins, 9 hard lining materials, and 7 soft denture lining materials] Roughness measurements were made using Mitutoyo surftest SV-400, and the mean arithmetic roughness values

(Ra) were obtained. The roughness exhibited by all of the materials tested (Ra values greater than 0.7µm) indicated that there was a possibility for plaque accumulation, since 0.2µm is considered the threshold below which no further bacterial adherence can be expected.

Iwao Hayakawa et al (2000)[63]- examined the changes in the masticatory function of complete denture wearers after relining the mandibular denture with a soft liner and it was shown that applying a soft lining material to the mandibular dentures improved the masticatory function with no adverse effect on the muscular task..

Han-Kuang Tan et al (2000)[64] - compared the color, texture and Shore A hardness of a resilient silicone denture liner with as-polymerized, roughened, or pumiced surfaces after treatment with perborate, persulfate or hypochlorite containing denture cleanser and concluded that after treating silicone resilient denture liner with perborate containing denture cleanser, great amount of components leached from the liner leading to a loss of color if the liner surface is rough.

H. Murata et al (2001)[65]- evaluated the effect of addition of ethyl alcohol on gelation characteristic and viscoelastic properties after gelation and compared the effect of ethyl alcohol with that of the P/L ratio. It was

concluded that the addition of ethyl alcohol produced the shorter gelation time and the larger flow after gelation and the use of a higher P/L ratio produced a shorter gelation time and smaller flow after gelation.

Gornitsky M et al (2002)[27]- assessed the efficacy of 3 denture cleansers in reducing the number of microorganisms on dentures in a hospitalized geriatric population and concluded that the use of denture cleansers significantly reduced the number of microorganisms on dentures in a hospitalized geriatric population.

Hans S. Malmstrom et al (2002)[66]- evaluated the effect of 2 different coatings (Permaseal and Monopoly) on the surface integrity and softness of a tissue conditioner over a 4- week period and concluded that application of Permaseal and Monopoly coatings significantly reduced the loss of tissue conditioner softness.

Hiroshi Murata et al (2002)[67] – evaluated the effect of tissue conditioners on the dynamic viscoelastic properties of a heat polymerized denture base acrylic resin and concluded that some tissue conditioners significantly plasticized the denture base acrylic resin 0.5mm thick. However, there was no plasticization by the tissue conditioners when the thickness of denture base was 1.0mm thick.

Jin C et al (2003)[68] – evaluated the changes in surface roughness and color stability of soft denture lining materials caused by denture cleansers. Surface roughness of the soft denture lining materials was measured by contact type surface roughness instrument and color changes were quantitatively measured by a photometrical instrument. It was concluded that an auto polymerizing silicone material, Evatouch, exhibited severe changes in surface roughness by all denture cleanser, and the generic material GC Denture Relining showed the minimal changes. Severe color changes were also observed with some liner and cleanser combinations.

Renata C.M. Rodrigues Garcia et al (2003)[69] **-** evaluated the effect of a denture cleanser (Polident) on weight change, roughness and tensile bond strength on two denture resilient lining materials (COE-soft and Onda-cryl). Weight changes were recorded in milligrams, roughness was evaluated by profilometer and tensile bond strength was determined with a universal testing machine. It was concluded that the specimens immersed in denture cleanser demonstrated increased weight changes of resilient liners when compared with tap water, but surface roughness and tensile bond strength were unaffected.

H. Nikawa et al (2003)[29]- evaluated the biofilm formation of candida albicans on the surfaces of soft denture lining materials immersed in denture cleansers and suggested that daily cleaning of soft lining materials with mismatched denture cleanser will promote the subsequent biofilm formation.

Rodrigues Garcia RC et al (2004) [70]- evaluated the effect of denture cleansers on the surface hardness of a denture base resin, and on the surface roughness of the resin and Co-Cr and Ti-6Al-4V alloys and concluded that the cleanser containing sodium perborate increased surface roughness and hardness, probably due to its incapacity to remove the pellicle formed on the acrylic resin and dental alloys.

Dinckal Yanikoglu N, Yesil Duymus (2004)[71] - investigated the percentage of absorption and solubility in artificial saliva, distilled water and denture cleanser of 2 acrylic based materials and 3 silicone rubber soft lining materials and the effect of denture cleanser on surface properties. It was concluded that the acrylic resin soft lining material had higher solubility (3.432% Viscogel in artificial saliva) and absorption (3.349% Viscogel in distilled water) than Molloplast B after 16 weeks of aging. The greatest hardness and color change were shown in the acrylic soft lining materials.

Bulad K et al (2004)[72]- evaluated the colonization and penetration of denture soft lining materials by Candida albicans and concluded that different denture lining materials exhibit different properties in terms of susceptibility to yeast penetration and smoother surfaces retain fewer cells. The selection of appropriate materials for a given function, and their fabrication may affect performance.

Mese A. et al (2005)[73]- investigated the effect of storage duration on the tensile bond strength of acrylic or silicone based soft denture liners to a processed denture base polymer and concluded that the tensile bond strength of acrylic based soft liners is greater than that of silicone based materials. The bond strength of all lining materials decreased with storage duration: the decrease being greatest for the acrylic based soft liners. The decrease in bond strength of the auto cured materials is greater than that of the heat cured products.

Hiroshi Murata et al (2005)[74]- evaluated the compatibility of three tissue conditioners (COE-comfort, Soft-conditioners, and Visco-gel) with dental stones and changes in surface conditions over time, using profilometer and concluded that the type of tissue conditioners, and especially immersion time had a significant effect on the surface quality of dental stone cast. The type of dental stone used is less important.

Douglas G. Benting et al (2005)[75]- compared the compliance of resilient denture liners immersed in effervescent denture cleansers (Fixodent or Efferdent) and concluded that the exposure of resilient soft liners to cleansers results in increased flexibility and the change in flexibility depends on the type of denture cleanser and on the immersion time.

Murata H. et al (2006)[76]- measured the gelation characteristic, viscoelastic properties and compatibility with dental stones of a alcohol free tissue conditioner (Fictioner) and 3 tissue conditioners containing ethyl alcohol(FITT, Hydrocast and SR-Ivoseal). The effect of a coating, which consisted of poly (ethyl methacrylate) and methyl methacrylate, was also evaluated. The results of this study suggested that the coated alcohol free tissue conditioner would be superior to the conventional materials containing ethyl alcohol in view of viscoelastic properties after gelation, compatibility with dental stones and durability.

Marcio jose Mendonca et al (2006)[77]- evaluated the effect of 2 post polymerization treatment (immersion in water at 55°C and microwave irradiation) on tooth brushing wear (weight loss) and surface roughness of 3 auto polymerized reline resins (Duraliner II, Kooliner, Tokusa Rebase Fast) and 1 heat polymerized resin (Lucitone 550) and it

was concluded that the post polymerization treatments did not improve the tooth brushing wear resistance of the materials and produced an increased surface roughness for materials.

E. M. C. X. Lima et al (2006)[25]- evaluated the effect of denture cleansers on surface roughness of acrylic resin and on biofilm accumulation and it was suggested that the roughness of acrylic resin was not changed by the cleansers but the ability to reduce biofilm accumulation depended on the product used.

MATERIALS AND METHODS

MATERIALS

1. Tissue conditioner (Visco-gel, De Trey/ Dentsply, Weybridge, Surrey, United Kingdom) (figure-4)
2. Denture cleanser (Fitty Dent, Group Pharmaceuticals LTD., Mumbai, India) (figure-5)
3. Disinfectant (Hexidine, ICPA Health Products Ltd., India). (figure-6)
4. Acrylic Repair Material (DPI-RR Cold cure, The Bombay Burmah Trading Corporation, Ltd., India) (figure-8)
5. Coating agent (Monopoly) (figure-7)
6. Distilled water

Table I-Materials

Code	Materials	Composition	Manufacturer
TC	Visco-gel	Powder: Polyethyl methacrylate Liquid: Phthalyl butyl glycolate,Ethanol	Dentsply
DC	Fitty Dent	Sodium Bicarbonate, Sodium Perborate Monohydrate	Group Pharmaceuticals LTD.
DIS	Hexidine	0.2% Chlorhexidine Gluconate	ICPA Health Products Ltd.
M	Monopoly	1 part clear methyl methacrylate polymer and 10 part chemically activated methyl methacrylate monomer	Indigenous

METHODS

Preparation of the specimens

A polypropylene mold of 3mm thickness and 20mm internal diameter was made (figure-9) and the specimens were prepared by mixing 3g (one measure) of powder of Visco-gel with 2.2ml (one measure) of liquid (figure-10), for 30 seconds, and after 2 minutes, the Visco-gel was poured into the mold and was pressed with a glass slab (figure-11) for 2hours.[35, 74] The specimens were removed and stored in the sterile glass jar having distilled water (figure-17).

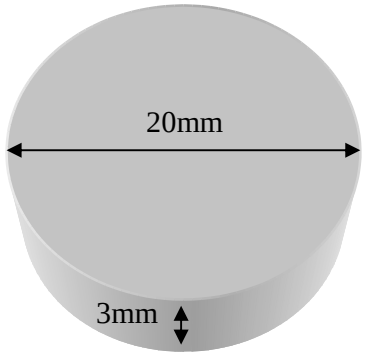

Fig. 1 : Dimensions of disk shaped sample

Grouping of the specimens

60 disk-shaped specimens of Visco-gel were made (figure-12) and divided into 6 groups of 10 each (control 1, control 2, control 2, group 1, group 2 and group 3).

Table-II Grouping of specimens

Control 1 (C1)	TC
Control 2 (C2)	TC + DC
Control 3 (C3)	TC + DC + DIS
Group 1 (G1)	TC + M
Group 2 (G2)	TC + M + DC
Group 3 (G3)	TC + M + DC + DIS

Control 1- This group consist of specimens with no treatment.

Control 2- This group consists of specimens immersed in denture cleanser.

Control 3- This group consist of specimens immersed in denture cleanser and treated with disinfectant.

Group 1- This group consists of samples painted with Monopoly three times on all surfaces, and each layer was allowed to dry for 3 minutes before recoating.[35]

Preparation of Monopoly

Monopoly was prepared by mixing 200g (figure-14) of chemically activated methyl methacrylate monomer and 20g (figure-13) of clear methyl methacrylate polymer (1:10) in a glass beaker in a water bath at 55º C (figure-15), and stirred for 8-10 minutes (figure-16) until the mixture started to thicken. The syrup-like liquid was then stored in a dark bottle (figure-7) at 4ºC and was applied to the tissue conditioner specimens as they were completed.[35]

Group 2- This group consists of specimens painted with Monopoly and immersed in denture cleanser

Group 3- This group consists of specimens painted with Monopoly, immersed in denture cleanser and treated with disinfectant

For Control 2, Control 3, Group 2 and Group 3, specimens were immersed into solution of denture cleanser (figure-18) for 8 hrs at room temperature, washed thoroughly with tap water and distilled water, and immersed into distilled water for the remainder of the 24 hrs period. The preparation of fresh cleanser solution was continually repeated for 14 days.[28] Control 3 and Group 3 specimens were treated with disinfectant (figure-19) for 10 minutes before testing the surface roughness.[78] The surface roughness was measured on 1, 3, 5, 7 and 14 days, since the

reported loss of ester plasticizer ranged from 0.3mg per g to 8.7mg per g with in 14 days[35], using contact profilometer.

Contact profilometer

The contact profilometer used in this study was Mitutoyo Surftest SJ-400 (figure-20) and the method used was to scan a diamond stylus (figure-21) across the surface under a constant load and compute the numeric values representing the roughness of the profile as Ra. The Ra value describes the overall roughness of a surface and is defined as the arithmetic mean value of all absolute distances of the roughness profile from the center line with in the measuring length.[79] Ra values were obtained using a Mitutoyo Surftest SJ-400 with a traversing length of 30mm and a cutoff length of 2.5mm. According to the manufacturer's instruction, a diamond stylus of 5µm tip radius was used under a constant measuring force of 3.9mN. On each specimen 3 passes were carried out, and the mean Ra of these 3 readings was used for the statistical analysis.

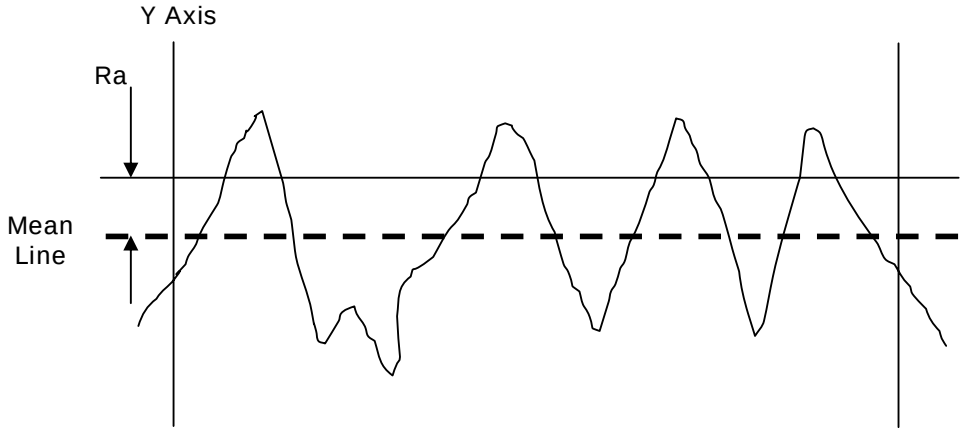

Fig.2 : Graphic representation of Ra

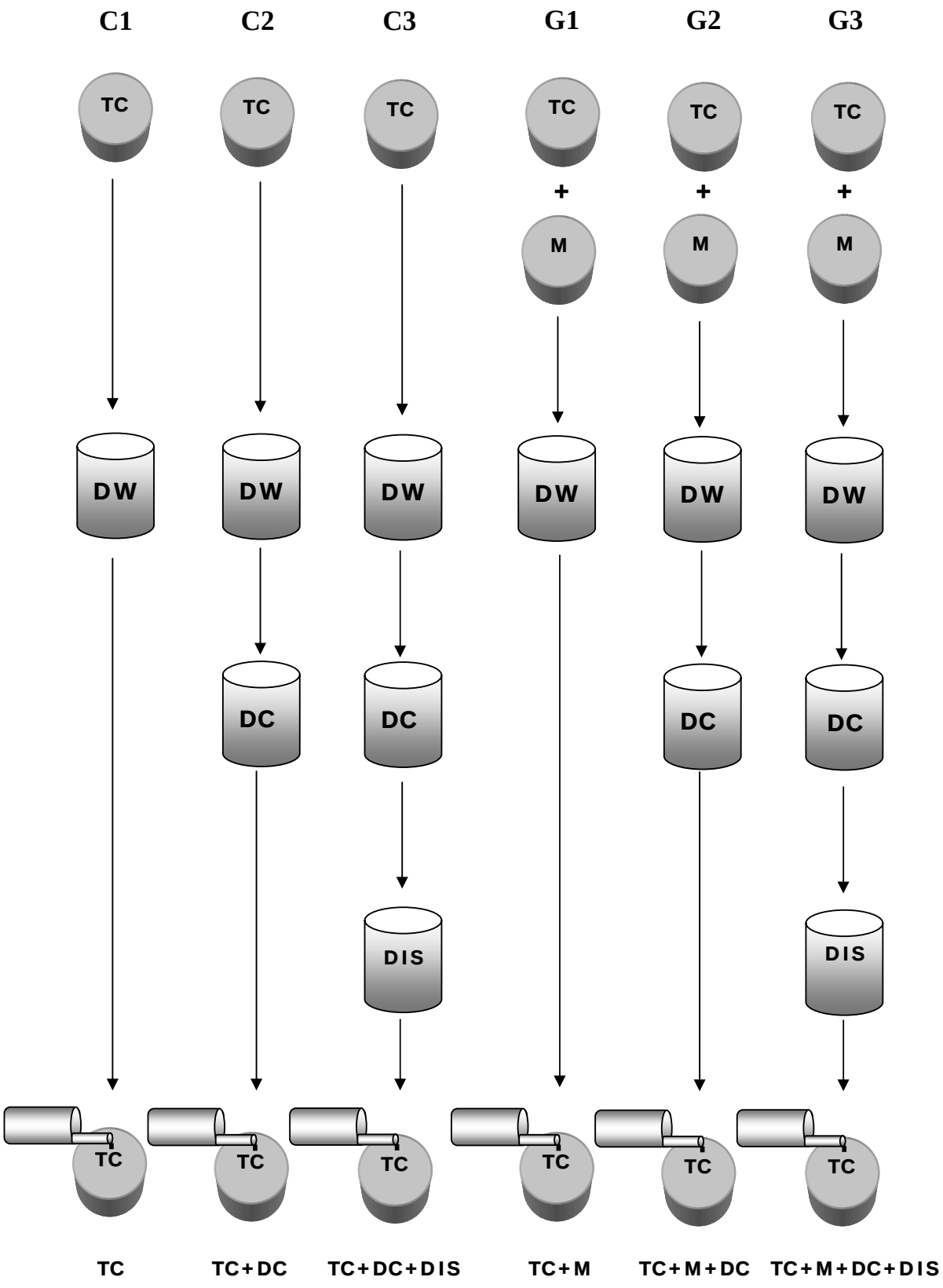

Fig.3 : Schematic representation of grouping of samples

RESULTS

The surface roughness of a tissue conditioner-Visco-gel (TC) was evaluated, using contact profilometer (Mitutoyo Surftest SJ-400, Japan), with and without Monopoly coating and subjected to routine use of denture cleanser and disinfectant. The specimens were divided into 6 groups of 10 each (control 1, control 2, control 3, group 1, group 2, and group 3). In control 1 (C1) no treatment was done, in control 2 (C2) they were immersed in denture cleanser DC), in control 3 (C3) they were immersed in denture cleanser (DC) and disinfectant (DIS), in group 1 (G1) specimens were coated with monopoly (M), in group 2 (G2) they were coated with monopoly (M) and immersed in denture cleanser (DC) and in group 3 (G3) they were coated with monopoly (M) and immersed in denture cleanser (DC) and disinfectant (DIS).

Control 1 (C1) - TC

Control 2 (C2) - TC + DC

Control 3 (C3) - TC + DC + DIS

Group 1 (G1) - TC + M

Group 2 (G2) - TC + M + DC

Group 3 (G3) - TC + M + DC + DIS

The surface roughness (Ra) was measured on Day1, Day3, Day5, Day7 and Day14. On each specimen 3 passes were carried out, and the mean Ra of these 3 readings was used for the statistical analysis. Students paired t-test was used to compare the mean values between different time prints within each study group. The mean and standard deviation were estimated for each study group and were compared between different study groups by using either student's independent t-test or one-way ANOVA followed by Tukey-HSD procedure appropriately.

In the present study, $P<0.05$ was considered as the level of significance.

Table III: Comparison of mean values between different study groups (Control Group)

Variable	Group	Mean ± S.D.	p-value	Sig. group at 5% level
Day – 1	C1 C2 C3	1.29 ± 0.23 2.11 ± 0.12 3.01 ± 0.48	< 0.0001	C3 Vs C1, C2, C2 Vs C1.
Day – 3	C1 C2 C3	2.44 ± 0.68 3.32 ± 0.56 4.28 ± 0.63	< 0.0001	C3 Vs C1, C2, C2 Vs C1.
Day – 5	C1 C2 C3	3.12 ± 0.35 4.77 ± 0.33 6.22 ± 0.42	< 0.0001	C3 Vs C1, C2, C2 Vs C1.
Day – 7	C1 C2 C3	4.04 ± 0.18 6.12 ± 0.23 8.15 ± 0.21	< 0.0001	C3 Vs C1, C2, C2 Vs C1.
Day – 14	C1 C2 C3	9.23 ± 0.37 13.01 ± 0.17 15.55 ± 0.36	< 0.0001	C3 Vs C1, C2, C2 Vs C1.

The mean surface roughness values of tissue conditioner not coated with monopoly tended to increase from day 1 to day 14 and ranged from 1.29 ± 0.23 to 15.55 ± 0.36.

The mean surface roughness value of C3 (immersed in denture cleanser and disinfectant) was significantly higher than mean surface roughness value of C1 (no treatment) and C2 (immersed in denture cleanser). Further, the mean surface roughness value of C2 was significantly higher than the mean surface roughness values of C1 on all days ($p < 0.0001$).

Table IV: Comparison mean values between different study groups (Test Group)

Variable	Group	Mean ± S.D.	p-value	Sig. group at 5% level
Day – 1	G1 G2 G3	0.75 ± 0.09 0.83 ± 0.06 1.11 ± 0.13	< 0.0001	G3 Vs G1, G2.
Day – 3	G1 G2 G3	1.15 ± 0.10 1.48 ± 0.12 1.71 ± 0.11	< 0.0001	G3 Vs G1, G2, G2 Vs G1.
Day – 5	G1 G2 G3	1.42 ± 0.10 1.83 ± 0.17 2.17 ± 0.22	< 0.0001	G3 Vs G1, G2, G2 Vs G1.
Day – 7	G1 G2 G3	1.95 ± 0.13 2.25 ± 0.13 2.88 ± 0.10	< 0.0001	G3 Vs G1, G2, G2 Vs G1.
Day – 14	G1 G2 G3	3.11 ± 0.13 4.07 ± 0.15 6.08 ± 0.11	< 0.0001	G3 Vs G1, G2, G2 Vs G1.

The mean surface roughness values of tissue conditioner coated with monopoly tended to increase from day 1 to day 14 and ranged from 0.75 ± 0.09 to 6.08 ± 0.11.

The mean surface roughness value of G3 (coated with monopoly and immersed in denture cleanser and disinfectant) was significantly higher than the mean surface roughness values of G1 (coated with monopoly) and G2 (coated with monopoly and immersed in denture cleanser) on all days ($p < 0.0001$). Further, the mean surface roughness value of G2 was significantly higher than the mean surface roughness value of G1 on Day 3, Day 5, Day 7 and Day 14 ($p < 0.0001$).

Table V: Mean, Standard deviation and test of significance of mean values between Group C1 and G1

Variable	Group C1	Group – G1	P – value
	Mean ± S.D.	Mean ± S.D.	
Day – 1	1.29 ± 0.23	0.75 ± 0.09	< 0.0001
Day – 3	2.44 ± 0.68	1.15 ± 0.10	< 0.0001
Day – 5	3.12 ± 0.35	1.42 ± 0.10	< 0.0001
Day – 7	4.04 ± 0.18	1.95 ± 0.13	< 0.0001
Day – 14	9.23 ± 0.37	3.11 ± 0.13	< 0.0001

The mean surface roughness value of group C1 (without monopoly coating) was 1.29 ± 0.23, which was significantly higher than mean surface roughness value of group G1 (with monopoly coating) on Day 1 ($p< 0.0001$). The mean surface roughness value of group C1 (2.44 ± 0.68) was significantly higher than mean surface roughness value of group G1 (1.15 ± 0.10) on Day 3 ($p< 0.0001$). The mean surface roughness value of group C1 (3.12 ± 0.35) was significantly higher than mean surface roughness value of group G1 (1.42 ± 0.10) on Day 5 ($p< 0.0001$). The mean surface roughness value of group C1 (4.04 ± 0.18) was significantly

higher than mean surface roughness value of group G1 (1.95 ± 0.13) on Day 7 ($p < 0.0001$). The mean surface roughness value of group C1 (9.23 ± 0.37) was significantly higher than mean surface roughness value of group G1 (3.11 ± 0.13) on Day 14 ($p < 0.0001$).

Table VI: Mean, Standard deviation and test of significance of mean values between Group C1 and G1

Change	Group C1	Group – G1	P – value
	Mean ± S.D.	Mean ± S.D.	
Day 1 to Day 3	1.15 ± 0.47	0.40 ± 0.02	< 0.001
Day 3 to Day 5	0.68 ± 0.75	0.28 ± 0.15	< 0.13
Day 5 to Day 7	0.93 ± 0.48	0.53 ± 0.20	< 0.04
Day 7 to Day 14	5.18 ± 0.42	1.16 ± 0.19	< 0.0001
Day 1 to Day 14	7.94 ± 0.36	2.37 ± 0.17	< 0.0001

The change in mean surface roughness values of group C1 (without monopoly coating) from day 1 to day 3 was 1.15 ± 0.47 and the change of mean surface roughness values of group G1 (with monopoly coating) was 0.40 ± 0.02, which was significant ($p< 0.001$). The change in mean surface roughness values of group C1 from day 3 to day 5 was 0.68 ± 0.75 and the change of mean surface roughness values of group G1 was 0.28 ± 0.15, which was not significant ($p< 0.13$). The change in mean surface roughness values of group C1 from day 5 to day 7 was 0.93 ± 0.48 and the change of mean surface roughness values of group G1 was 0.53 ± 0.20, which was significant ($p< 0.04$). The change in mean

surface roughness values of group C1 from day 7 to day 14 was 5.18 ± 0.42 and the change of mean surface roughness values of group G1 was 1.16 ± 0.19, which was significant ($p < 0.0001$). The change in mean surface roughness values of group C1 from day 1 to day 14 was 7.94 ± 0.36 and the change of mean surface roughness values of group G1 was 2.37 ± 0.17, which was significant ($p < 0.0001$).

Table VII: Mean, Standard deviation and test of significance of mean values between Groups C2 and G2

Variable	Group C2	Group – G2	P – value
	Mean ± S.D.	Mean ± S.D.	
Day – 1	2.11 ± 0.12	0.83 ± 0.06	< 0.0001
Day – 3	3.32 ± 0.56	1.48 ± 0.12	< 0.0001
Day – 5	4.77 ± 0.33	1.83 ± 0.17	< 0.0001
Day – 7	6.12 ± 0.23	2.25 ± 0.13	< 0.0001
Day – 14	13.01 ± 0.17	4.07 ± 0.15	< 0.0001

The mean surface roughness value of group C2 (without monopoly coating and immersed in denture cleanser) was 2.11 ± 0.12, which was significantly higher than mean surface roughness value of Group G2 (with monopoly coating and immersed in denture cleanser) on day 1 ($p< 0.0001$). The mean surface roughness value of group C2 (3.32 ± 0.56), was significantly higher than mean surface roughness value of group G2 (1.48 ± 0.12) on day 3 ($p< 0.0001$). The mean surface roughness value of group C2 (4.77 ± 0.33), was significantly higher than mean surface

roughness value of group G2 (1.83 ± 0.17) on day 5 ($p < 0.0001$). The mean surface roughness value of group C2 (6.12 ± 0.23), was significantly higher than mean surface roughness value of group G2 (2.25 ± 0.13) on day 7 ($p < 0.0001$). The mean surface roughness value of group C2 (13.01 ± 0.17), was significantly higher than mean surface roughness value of group G2 (4.07 ± 0.15) on day 14 ($p < 0.0001$).

Table VIII: Mean, Standard deviation and test of significance of mean values between Group C2 and G2

Change	Group C2	Group – G2	P – value
	Mean ± S.D.	Mean ± S.D.	
Day 1 to Day 3	1.21 ± 0.46	0.65 ± 0.06	< 0.004
Day 3 to Day 5	1.45 ± 0.73	0.35 ± 0.23	< 0.001
Day 5 to Day 7	1.35 ± 0.32	0.42 ± 0.19	< 0.0001
Day 7 to Day 14	6.89 ± 0.37	1.82 ± 0.22	< 0.0001
Day 1 to Day 14	10.90 ± 0.23	3.23 ± 0.15	< 0.0001

The change in mean surface roughness values of group C2 (without monopoly coating and immersed in denture cleanser) from day 1 to day 3 was 1.21 ± 0.46 and the change of mean surface roughness values of group G2 (with monopoly coating and immersed in denture cleanser) was 0.65 ± 0.06, which was significant ($p< 0.004$). The change in mean surface roughness values of group C2 from day 3 to day 5 was 1.45 ± 0.73 and the change of mean surface roughness values of group G2 was 0.35 ± 0.23, which was significant ($p< 0.001$). The change in mean surface roughness values of group C2 from day 5 to day 7 was 1.35 ± 0.32 and the change of mean surface roughness values of group G2 was

0.42 ± 0.19, which was significant ($p < 0.0001$). The change in mean surface roughness values of group C2 from day 7 to day 14 was 6.89 ± 0.37 and the change of mean surface roughness values of group G2 was 1.82 ± 0.22, which was significant ($p < 0.0001$). The change in mean surface roughness values of group C2 from day 1 to day 14 was 10.90 ± 0.23 and the change of mean surface roughness values of group G2 was 3.23 ± 0.15, which was significant ($p < 0.0001$).

Table IX: Mean, Standard deviation and test of significance of mean values between Groups C3 and G3

Variable	Group C3	Group – G3	P – value
	Mean ± S.D.	Mean ± S.D.	
Day – 1	3.01 ± 0.48	1.11 ± 0.13	< 0.0001
Day – 3	4.28 ± 0.63	1.71 ± 0.11	< 0.0001
Day – 5	6.22 ± 0.42	2.17 ± 0.22	< 0.0001
Day – 7	8.15 ± 0.21	2.88 ± 0.10	< 0.0001
Day – 14	15.55 ± 0.36	6.08 ± 0.11	< 0.0001

The mean surface roughness value of group C3 (without monopoly coating and immersed in denture cleanser and disinfectant) was 3.01 ± 0.48, which was significantly higher than mean surface roughness value of group G3 (with monopoly coating and immersed in denture cleanser and disinfectant) on day 1 ($p< 0.0001$). The mean surface roughness value of group C3 (4.28 ± 0.63), was significantly higher than mean surface roughness value of group G3 (1.71 ± 0.11) on day 3 ($p< 0.0001$). The mean surface roughness value of group C3 (6.22 ± 0.42), was

significantly higher than mean surface roughness value of group G3 (2.17 ± 0.22) on day 5 ($p < 0.0001$). The mean surface roughness value of group C3 (8.15 ± 0.21), was significantly higher than mean surface roughness value of group G3 (2.88 ± 0.10) on day 7 ($p < 0.0001$). The mean surface roughness value of group C3 (15.55 ± 0.36), was significantly higher than mean surface roughness value of group G3 (6.08 ± 0.11) on day 14 ($p < 0.0001$).

Table X: Mean, Standard deviation and test of significance of mean values between Group C3 and G3

Change	Group C3	Group – G3	P – value
	Mean ± S.D.	Mean ± S.D.	
Day 1 to Day 3	1.27 ± 0.18	0.60 ± 0.04	< 0.0001
Day 3 to Day 5	1.94 ± 0.71	0.47 ± 0.25	< 0.0001
Day 5 to Day 7	1.92 ± 0.47	0.71 ± 0.23	< 0.0001
Day 7 to Day 14	7.41 ± 0.49	3.20 ± 0.08	< 0.0001
Day 1 to Day 14	12.54 ± 0.63	4.97 ± 0.17	< 0.0001

The change in mean surface roughness values of group C3 (without monopoly coating and immersed in denture cleanser and disinfectant) from day 1 to day 3 was 1.27 ± 0.18 and the change of mean surface roughness values of group G3 (with monopoly coating and immersed in denture cleanser and disinfectant) was 0.60 ± 0.04, which was significant ($p< 0.0001$). The change in mean surface roughness values of group C3 from day 3 to day 5 was 1.94 ± 0.71 and the change of mean surface roughness values of group G3 was 0.47 ± 0.25, which was significant ($p< 0.0001$). The change in mean surface roughness values of group C3 from day 5 to day 7 was 1.92 ± 0.47 and the change of mean surface roughness values of group G3 was 0.71 ± 0.23, which was significant ($p< 0.0001$).

The change in mean surface roughness values of group C3 from day 7 to day 14 was 7.41 ± 0.49 and the change of mean surface roughness values of group G3 was 3.20 ± 0.08, which was significant ($p < 0.0001$). The change in mean surface roughness values of group C3 from day 1 to day 14 was 12.54 ± 0.63 and the change of mean surface roughness values of group G3 was 4.97 ± 0.17, which was significant ($p < 0.0001$).

DISCUSSION

Soft denture liners are generally classified into (a) Short term soft liners and (b) Long term soft liners.[9] The longevity of short term soft liners or tissue conditioners may be, from a week to a month.[33,34] Tissue conditioners have been used in managing patients with abused tissues underlying ill-fitting dentures, and in making functional impressions. It also serves as a "shock absorber" between the occlusal surfaces of a denture and the underlying oral tissues.[80] These are highly plasticized acrylic resins supplied as a powder/liquid system. The powder is poly (ethyl methacrylate) and the liquid is an ester plasticizer, such as dibutyl phthalate, or (butyl phthalyl butyl glycolate / butyl benzyl phthalate / dibutyl sebacate) and ethyl alcohol. One of the disadvantages of a tissue conditioner is that it gradually hardens and becomes rough with time, due to the leaching out of plasticizers and ethanol, affecting the mucosal health.

Surface roughness increases the area available for adhesion and provides niches in which micro-organisms are protected from shear forces, thus giving microbial cells time to become irreversibly attached to

a surface. [18,19] Hence, it is essential to have a surface which is relatively clean and smooth to maintain good oral health.

Denture cleansers are effective in preventing microbial invasion and plaque formation[21-25] but have been reported to cause significant surface deterioration of tissue conditioners in a relatively short time, [28,29] which necessitates their frequent replacement. It is also mandatory to disinfect the prosthesis to reduce the chances of cross contamination between the patient and the dental personnel. [30-32] The longevity of a tissue conditioner may be extended by covering the surface with a coating agent, [33-38] or by incorporating anti-fungal agents into the tissue conditioners. However, the amount of anti-fungal agents used to inhibit colonization would be too costly to use routinely. [42,61,81]

Monopoly is a cost-effective method of extending the longevity of a tissue conditioner, which act as a barrier and minimizes the leaching out of the plasticizer, and ethyl alcohol, which results in fewer surface irregularities and keeps the surface area clean and smooth[35]. It has also been reported that coating tissue conditioners with monopoly can extend the life the tissue conditioner to a year[37] as it maintains the resiliency of tissue conditioner[38] and seals the pores, preventing the entry of microorganisms.[36]

Hence, the effect of surface coating on the surface roughness of tissue conditioners subjected to the action of denture cleanser and disinfectant was evaluated and compared with control groups, not coated with monopoly, for a period of 14 days.

The tissue conditioner visco-gel was preferred because it is transparent which facilitates visual evaluation of voids[43] and is suitable for conditioning abused tissues because of its larger flow and lower rate of flow property with time.[8] As the ethanol content in the tissue conditioner is increased, the shrinkage overtime is increased and the flow properties are decreased. Viscogel contains less than 10 wt% ethanol, which results in decreased shrinkage and increased flow properties.[55] The constant leaching of plasticizers and ethanol in the set tissue conditioner gel plasticizes the underling denture base resin during use but since Visco-gel contains a considerably low percentage of ethanol and a higher molecular weight ester (butyl phthalyl butyl glycolate) it has almost no influence on the viscoelastic properties of acrylic resin.[67] Visco-gel contains 94% butyl phthalyl butyl glycolate and it has been observed that butyl phthalyl butyl glycolate leaches less than di-butyl phthalate.[35]

Mechanical and chemical cleansing methods have been proposed for routine denture cleansing. Mechanical cleansing is not as effective as

chemical cleansing in reducing plaque, [23,48 82] hence chemical cleansing is indispensable for daily denture care. In the present study, the denture cleanser used was peroxide based (Fitty dent), which works basically through an oxygen liberating mechanism which loosens debris and removes stains.

Immersion of dentures in chlorhexidine solution for a few minutes causes a significant reduction in the amount of denture plaque.[21] Its mechanism of action is associated with the attractions between positively charged chlorhexidine ions (cation) and negatively charged bacterial cells (anions). After chlorhexidine is absorpted onto the organism's cell wall, it disrupts the integrity of the cell membrane and causes the leakage of intracellular components of the organisms. In the present study 0.2% chlorhexidine gluconate was preferred since it has been reported that higher concentration (0.5%) of it significantly affects the hardness of acrylic resin when immersed for 7 days.[78]

Methods to evaluate the roughness of a surface include, contact stylus tracing[18,19,29,33,79], laser reflectivity[79], scanning electron microscopy[34] and Rigid analysis[22,28]. In the present study the contact stylus tracing device (Mitutoyo Surftest SJ-400) was preferred because of its reproducibility and accuracy.

Specimens were prepared by mixing 3g (one measure) of powder of Visco-gel with 2.2ml (one measure) of liquid according to manufacturer's instruction for 30 seconds and after 2 minutes, the visco-gel was poured into the mold of 3mm thickness and 20mm internal diameter[35] and was pressed with a glass slab for 2hours. [74] The specimens were removed and stored in the sterile glass jar having distilled water.[28] Specimens of 3mm thickness were prepared because a 3mm thickness of soft lining material is most suitable for improving the pressure distribution on supporting tissues under the denture.[49,67]

60 disk shaped specimens were prepared and were divided into 6 groups of 10 each (Table-II). Since monopoly is not commercially available, it was prepared indigenously, [66] and was applied on the surface of specimens, of group (G1, G2, G3), three times. Each layer was allowed to dry for 3 minutes before recoating.[35]

Peroxide cleansers seem to be the most effective method in eliminating microorganisms when the denture is soaked in it for several hours or overnight. [21, 82] Specimens of group (C2,C3,G2,G3) were immersed into solution of denture cleanser for 8 hours, which is the recommended time and then stored in distilled water for the rest of the 24 hours period.[28,68] Specimens of group (C3 and G3) were immersed in

solution of 0.2% chlorhexidine gluconate for ten minutes prior to testing.[78]

The surface roughness of all the specimens was measured on 1, 3, 5, 7 and 14 days since, the reported loss of ester plasticizer ranged from 0.3mg per gm to 8.7mg per gm within 14 days.[35]

The results of the study showed that the mean surface roughness values of all the specimens increased from day1 to day14 (graph-1) since the tissue conditioners are loosely structured plasticized gels that contain minimal, cross linked, plasticized polymers. These plasticizers leach out resulting in surface alteration. Moreover, it has been reported that immersion in water significantly reduces the compliance (compressibility and flexibility) of a tissue conditioner within the first week.[52] The mean surface roughness values of the specimens not coated with monopoly was significantly higher than that of specimens coated with monopoly. These results were in accordance with the findings of Gardner[37] who reported that longevity of tissue conditioner can be extended up to 1 year, by coating the tissue surface with monopoly, and that the monopoly coating maintains the resilient characteristics and keep the surface clean and smooth decreasing the incidence of microbial growth.

The mean surface roughness value of group C1 was significantly higher than the mean surface roughness value of group G1 on all the days. (Table-V) These results indicate the surface deterioration of tissue conditioner due to leaching out of the low molecular weight plasticizer and ethyl alcohol from the material when immersed in water. [50] It was reported that most of the ethanol is lost during the first 24 hours,[35] and that the greatest loss occurs in the first 12 hours and peaks at approximately 60 hours. [50] However it was reported that the loss of surface integrity and surface roughness may begin in a matter of 3-4 days.[66] The change in mean surface roughness value of group G1 from day1 to day14 was approximately three times less than the change in mean surface roughness value of group C1. (Table-VI) This result is in accordance with the result of other investigators that coating tissue conditioner with monopoly may result in fewer surface irregularities[34, 37]. The surface coated tissue conditioners retained their surface integrity, which may be due to reduced leaching out of the plasticizers.[34]

When mean surface roughness values of group C2 (without monopoly coating and immersed in denture cleanser) was compared with group G2 (with monopoly coating and immersed in denture cleanser) it was found that the value of group C2 was significantly higher than that of

group G2.(Table-VII) This increased value of group C2 is in accordance with the result of Hiroki Nikawa[28] who reported that denture cleansers can cause increased deterioration of the surface as they cause loss of soluble components and plasticizers or absorption of water / saliva by the resilient lining materials. Since the manufacture of the cleanser recommended the mixing of cleanser in warm water, the temperature of the water to be mixed with the cleanser was standardized at 37.7ºC. The use of warm water in combination with a cleanser might have caused a more rapid surface deterioration.[22] The change in mean surface roughness value of group G2 was approximately 3 times less than the change in mean surface roughness value of group C2 from day1 to day 14, (Table-VIII) which suggests that monopoly coating even reduces the effect of denture cleanser, as it forms a barrier and thus inhibits the leaching of the plasticizers[66].

When group C3 (without monopoly coating and immersed indenture cleanser and disinfectant) was compared with group G3 (with monopoly coating and immersed in denture cleanser and disinfectant) it was found that the mean surface roughness value of group C3 was significantly higher than that of group G3 (Table-IX) and the change in mean surface roughness value was approximately 2.5 times more than

that of group G3 from day1 to day 14. These results could again be due to the effect of monopoly coating agents, which inhibit the leaching of plasticizers and maintain the surface, integrity even in presence of the denture cleanser and disinfectant.

The mean surface roughness of group C3 was significantly higher than the mean surface roughness of group C2 (Table-III) and the mean surface roughness of group G3 was significantly higher than the mean surface roughness of group G2 (Table-IV) These results could be due to the slow absorption of the disinfectant into the resin that might result in changes in the structure of the polymer thereby causing leakage of the smaller molecules causing further surface deterioration.[78,83]

The marginal increase in the mean surface roughness values of the groups coated with monopoly may be due to minimal leaching out of the monomer from the monopoly, [35] or due to exposure of the air bubbles that might have incorporated during mixing.[34]

In the present study the surface roughness of the specimens from both the groups were greater than 0.76µm, indicating that there is a possibility for plaque accumulation, since 0.2µm is considered the threshold below which no further bacterial adherence can occur.[18]

However, the surface roughness of the control group (1.29µm-15.55µm) was more than the surface roughness of the test group (0.75µm-6.08µm) which indicates that the surfaces of control group are more susceptible to bacterial colonization. The relatively smooth surface of the test group could be attributed to the presence of the coating agent despite the action of the cleanser and disinfectant.

The surface roughness of a tissue conditioner, in vivo, may vary due to variety of reasons like the effect of saliva, tissue surface irregularities, temperature changes and masticatory forces. Thus, it should be noted that changes in surface roughness of the materials over time may be clinically different from those obtained in the present study. Hence clinical simulation may be necessary to get more predictable results. In the present study the surface of the tissue conditioner was subjected to the pressure from the glass slab during polymerization, while allowing polymerization to occur intraorally against the resilient mucosa might have provide a better simulation of the mucosa. The use of artificial saliva would have simulated a more physiological environment. Since only one group tissue conditioner was tested, conclusions derived from this study may not be applicable to other tissue conditioners.

SUMMARY AND CONCLUSION

Tissue conditioners are used as relining materials to condition abused tissues. Over a period of time, their surface may become rough due to leaching of plasticizers and ethanol resulting in accumulation of plaque and microorganisms. The use of denture cleansers and disinfectants may further deteriorate the surface, increasing the chances of adherence of these microorganisms, affecting the health of mucosa.

The surface roughness of a tissue conditioner (Visco-gel) coated with monopoly, and subjected to the action of a cleanser and disinfectant was compared to control group, without any coating. From the study it was evident that the mean surface roughness values of the test group was always lower than that of the control group from day 1 to day 14. The mean surface roughness values of group G1 was less than C1, G2 was less than C2 and G3 was less than C3. This decrease in surface roughness of the test group with the coating (G1), cleanser (G2) and disinfectant (G3) compared to that of the control group could be attributed to the surface coating agent in the test groups resulting in a relatively smooth surface preventing adherence of microorganisms and

plaque, thereby improving the hygiene of the prosthesis and health of the mucosa. It extends the longevity of the prosthesis, reduces the frequency of visits and allows the clinician greater use of available resources.

Within the limitations of this study it can be concluded that:

1. The surface roughness of the monopoly coated tissue conditioner (test group) was less than regular tissue conditioner (control group) from day1 to day 14.

2. Monopoly coating agent prevents the deterioration and reduces the surface roughness of the tissue conditioner.

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Figure 4: Tissue Conditioner

Figure 5: Denture Cleanser

Figure 6: Disinfectant

Figure 7: Monopoly

Figure 8: Constituents of monopoly

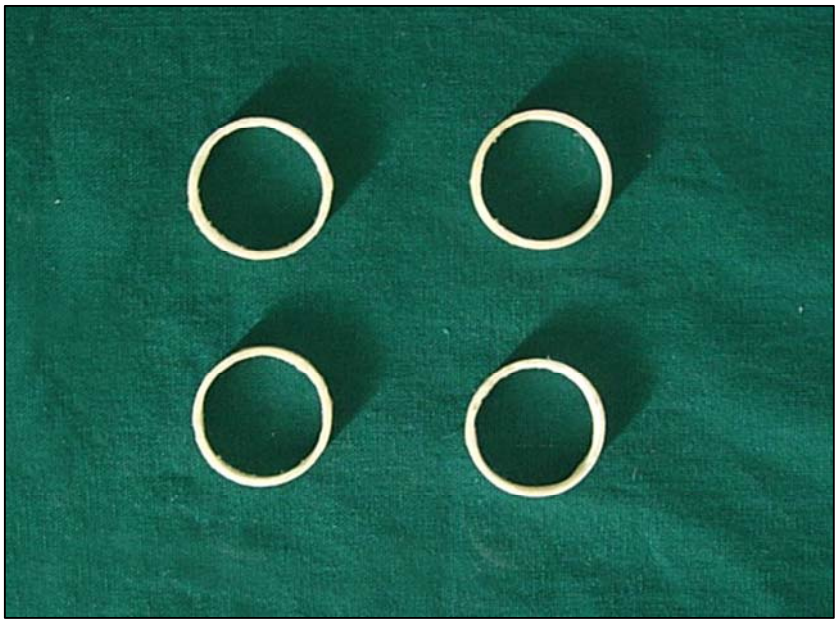

Figure 9: Polypropylene mold

Figure 10: Ratio of powder and liquid of viscogel

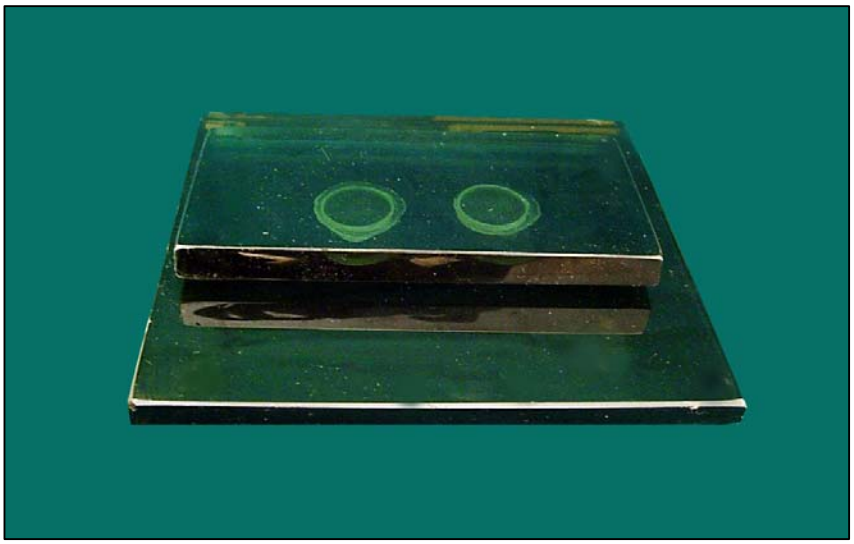

Figure 11: Glass slab pressed

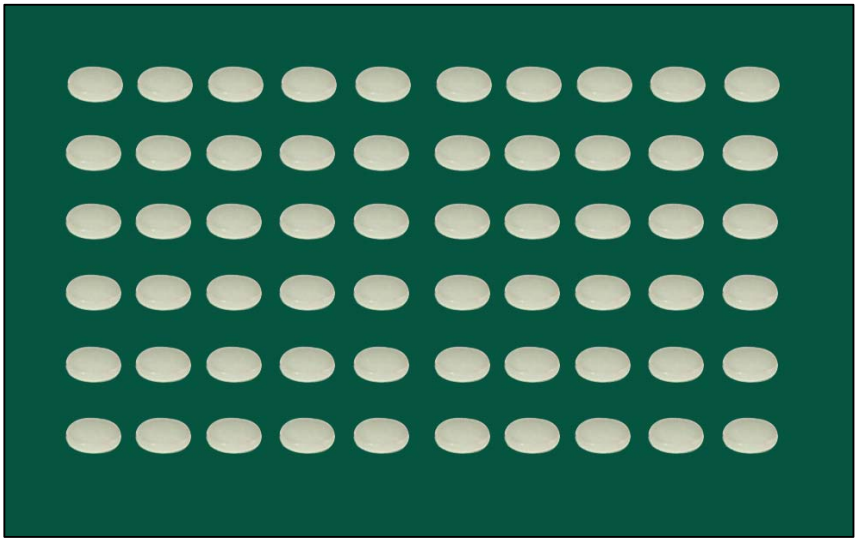

Figure12: Prepared samples

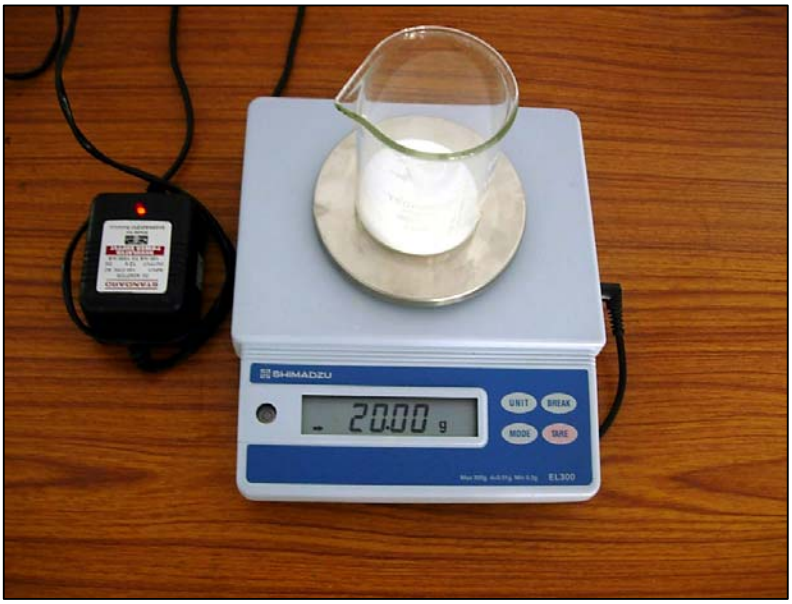

Figure 13: Weighing of polymer (20gms)

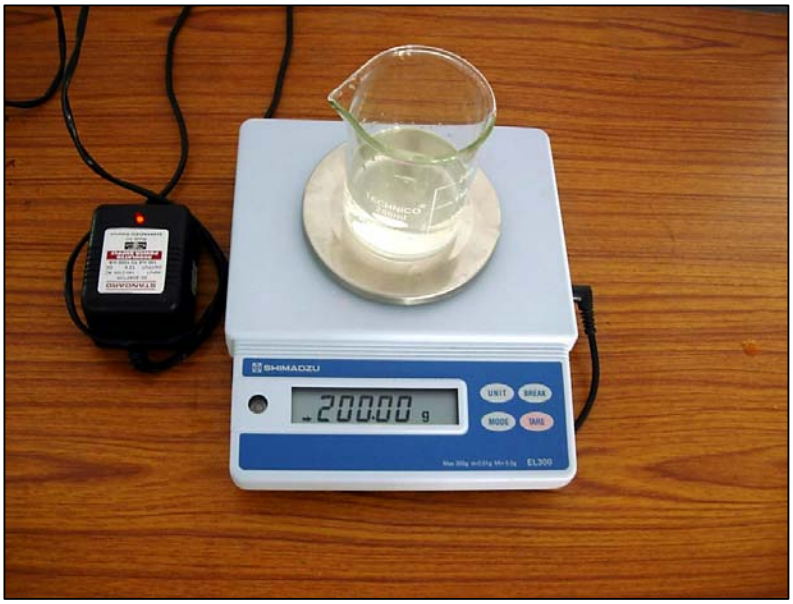

Figure 14: Weighing of monomer (200gms)

Figure 15: Water bath

Figure 16: Preparation of monopoly

Figure 17: Specimens stored in distilled water

Figure 18: Specimens immersed in denture cleanser

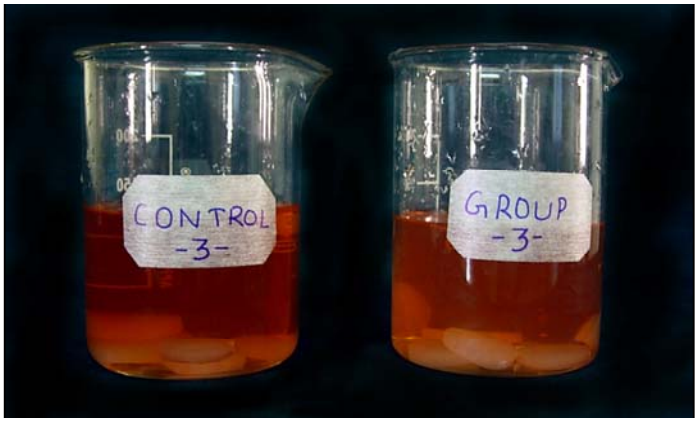

Figure 19: Specimens immersed in disinfectant

Figure 20: Contact profilometer

Figure 21: Close view of contact profilometer